# **Objective and Scope**

Our project aims to develop a 5G Indoor Testbed utilising O-RAN and Software Defined Radios (SDRs) to showcase the feasibility of implementing a 5G base-station in indoor environments. By leveraging open-source software and the National Instruments B-205-mini SDR module provided, we seek to provide advanced features and standalone capabilities for private networks in indoor settings. This initiative aligns with our broader goals of advancing telecommunication infrastructure and fostering innovation in wireless network technologies.

Our endeavour is driven by the purpose of demonstrating capabilities of utilizing open-source software and SDRs to implement 5G base-stations. Through this project, we aim to contribute to the advancement of 5G network infrastructure, enabling experimentation and testing of new network functionalities and services in controlled indoor settings.

Throughout the project, we will undertake various tasks to achieve our objectives. This includes studying and understanding the specifications outlined in the provided paper (arxiv.org: 2205.13178), designing the architecture and components of the 5G Indoor Testbed, implementing the system using an open-source software; srsRAN and the provided SDR module, and testing the system’s performance under various scenarios in indoor environments. Additionally, we will document the implementation process, providing setup instructions, configuration details, and testing procedures, and develop a user guide for operating the system. Finally, we will demonstrate the system's capabilities, highlighting its performance and functionality in indoor environments.

Ultimately, our final product will encompass a fully implemented 5G Indoor Testbed, comprehensive documentation detailing the implementation process, a user guide for operating the system, and possibly a pre-install tool to streamline setup and configuration depending on the client’s demands. Through the deliverables of this project, we aim to validate our approach and provide a valuable resource for researchers, developers, and telecommunications professionals interested in advancing 5G network infrastructure.

## High-Level Requirements

Our project will involve the following high-level requirements:

* Implementing O-RAN functionalities for a 5G base-station.
* Integrating Software Defined Radios (SDRs) for radio access.
* Developing software components to control the SDR module and manage network functionalities.
* Testing the system’s performance under various scenarios in indoor environments, using various metrics such as throughput and latency

## Project Requirements:

For our project, we need to:

* Implement the system according to the specifications outlined in the provided paper (arxiv.org: 2205.13178)
* Ensure compatibility with the National Instruments B-205-mini SDR module and appropriate antennas provided.
* Document the implementation process, including setup instructions, configuration details, and testing procedures.
* Provide a user guide for operating the system and a demonstration of its functionalities.
* Demonstration of the system for the client.

## Out of Scope:

Our project will not address the following:

* Implementation of 5G base-station functionalities for outdoor environments.
* Integration with proprietary hardware or software solutions.
* Large-scale deployment or production-ready system setup.

## Functional Requirements:

Our functional requirements include:

* Providing connectivity for user(s) within the network
* Providing connectivity for multiple user devices simultaneously
* Ensuring compatibility with standard 5G protocols and interfaces

## Nonfunctional Requirements:

Our nonfunctional requirements encompass:

* Performance: Achieving high throughput and low latency for data transmission.
* Reliability: Ensuring system availability and stability under varying network conditions.
* Scalability
* Security

## Technical Infrastructure:

* Hardware:
  + Standard laptop/PC: A sufficient computer system that can be used for running the necessary software and tools – both for developing and testing the 5G Indoor Testbed. An Intel NUC would fit this criteria for example.

Minimum hardware requirements as per the research paper:

* 4G testing: 2-core CPU, 4GB RAM, USB3.0
* 5G testing: 8-core CPU, 16GB RAM, 10Gbps NIC
  + National Instruments B-205mini SDR module (supplied by Ettus Research): The primary hardware component for implementing the radio access network (RAN) functionalities of the 5G base-station.
  + Specific antenna and connectors for B-205mini SDR
  + Deliberate USB3.0 Cable for B-205mini SDR
* Software:
  + srsRAN
  + Ubuntu (Linux distribution)
  + Docker/Docker Compose
  + VS Code
  + GitHub
  + Kubernetes
  + Ansible

## Skills Required:

* Hardware Configuration and Integration
* Troubleshooting and Debugging
* Networking skills
* Analytical skills; problem solving, critical thinking and attention to detail
* Project Management
* Documentation and Communication
* Collaboration

## Deliverable Summary:

The deliverable summary for the project includes the following:

## Project Management Deliverable:

* Client scope and objectives
* Team contract
* Project plan
* Project management plan
* Cost analysis
* Proposal
* Proposal presentation
* Meeting minutes
* Stakeholders register
* Gantt chart
* Skills analysis

## Final Product Deliverables:

1. Fully Implemented 5G Indoor Testbed: This includes the complete setup and configuration of the 5G Indoor Testbed using O-RAN principles and Software Defined Radios (SDRs).
2. Comprehensive Documentation: Detailed and comprehensible documentation covering the implementation process, setup instructions, configuration details, and testing procedures. The documentation will serve as a reference guide for users and stakeholders for future development.
3. User Guide: A user guide providing clear instructions on how to operate the 5G Indoor Testbed, including setup, configuration, usage, and troubleshooting tips. The user guide aims to ensure users can effectively utilize the system’s functionalities.
4. Demonstration of System: A demonstration showcasing the capabilities and functionalities of the 5G Indoor Testbed, highlighting its performance and usability in indoor environments. The demonstration will be tailored to meet the requirements and expectations of the project client and stakeholders.
5. Docker Image: A Docker image of the 5G Indoor Testbed, allowing for easy deployment and scalability across different environments. The Docker image ensures consistency and portability of the system’s configuration.
6. Pre-install Tool (potential deliverable based on client requirements): A pre-install tool designed to automate and streamline the setup and configuration process of the 5G Indoor Testbed. The tool aims to simplify the installation process for users and reduce the setup time.

## Milestones and Timeline:

It is key for our project that we have a set of solid milestones and a realistic timeline that the team can adhere to.

* Project kick-off and planning
* Research and Requirements Gathering:
* System Design and Architecture
* Upskilling
* Development and Configuration
* Hardware Configuration and Integration
* Testing and Validation
* Documentation and User Guide
* Demonstration and Client Review
* Finalization and Delivery

The project timeline spans one year, divided into two semesters. Semester one focuses on planning, research, design, upskilling, and initial setup. During this period, the team will initiate a project kick-off, planning, and initial research, followed by dedicated to in-depth research, requirements gathering, system design, and architecture. In weeks 9-12, a dedicated upskilling milestone is achieved, with training sessions and workshops conducted to enhance team members' skills. Initial hardware and software setup tasks are also initiated during this phase. Semester two, shifts focus to development, configuration, integration, testing, documentation, user guide creation, demonstration, and final delivery. Weeks 13-16 are allocated for software development, hardware configuration, integration, testing, and documentation efforts, while weeks 17-18 are dedicated to finalizing deliverables, conducting system demonstrations, and delivering the completed 5G Indoor Testbed to the project client.

## Project Success Criteria:

To ensure the successful delivery of a high-quality product, our team will prioritize effective communication and collaboration. We will hold weekly meetings as a group, often with our mentor and occasional client meetings to discuss progress, making sure we are on track and aligning priorities. During the research phase, we aim to share resources and insights to maximize coverage of relevant topics. Continuous learning will be key, so we plan to dedicate time to upskilling activities, enhancing our capabilities for project challenges.

We will be using secSDLC for our development approach, allowing for frequent feedback loops and adjustments based on stakeholder input. Our focus on quality assurance will involve conducting regular testing and validation to identify and address issues early on. Documenting project progress will facilitate knowledge sharing within the team, ensuring continuity and smooth transitions.

Furthermore, our collaborative relationship with the client will be vital, actively involving them particularly regarding technical feedback and guidance. For instance, the client’s clarity and specificity in outlining the approach to building the testbed, such as utilizing Docker and incorporating 4G LTE technology, will provide valuable direction for our team. Understanding the client’s expectation regarding deliverables ensures alignment with their vision. By actively involving the client in decision-making processes and seeking their input at key milestones, we aim to ensure that our project outcomes will meet or exceed all expectations.

## Constraints:

* Technical Constraints: Integration complexities between O-RAN, SDRs, and other technologies may pose challenges.
* Resource Constraints: Limited budget, time, and access to expertise may impact project progress.
* Scope Changes: Alterations in project requirements or scope could affect deliverables and timeframe.
* Regulatory Constraints: Compliance with radio frequency regulations may introduce obstacles.
* secSDLC Implementation: Strictly adhering to the secSDLC project management approach without flexibility may impact workflow and project execution.

## Assumptions:

* Hardware/Software Access: Assuming availability of required hardware and software for the project implementation.
* Technical Compatibility: Assuming compatibility between various technologies used in the project.
* Resource Constraints: Assuming availability of budget and time resources for project completion.
* Team Collaboration: Assuming effective collaboration among team members throughout the project.
* Team Roles and Deliverables: Assumed that assigned team roles and expectations of deliverables will be established; however, these assignments are subject to change as the project progresses.